Planetary Exploration in ESA

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Directorate of the Scientific Programme, ESA

Probe2WS, NASA-Ames, 23/08/04

Die Misionen der ESA

2012 BEPI COLOMBO — Mercury

2005 VENUS EXPRESS — Atmosphere & Surface (11-05)

2004 ROSETTA – Comet Orbiter & Lander (02-03-04)

2003 SMART-1-- Moon&SEP Technology (26-09-03)

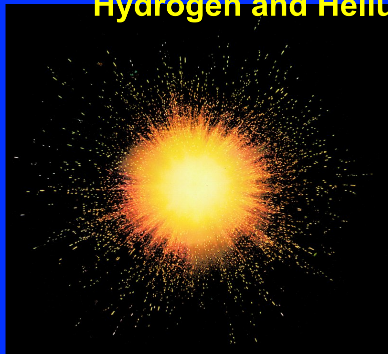
2003 Mars Express — Planetology & Exobiology (02-06-03)

1997 CASSINI-HUYGENS — Titan Probe

1985 GIOTTO — Halley's Comet Fly-by & Grigg-Skjellerup Fly-by

History of the solar system material

Big Bang, 13 Billion years, creation of Hydrogen and Helium

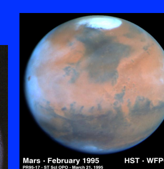


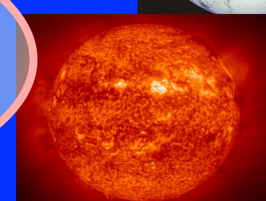
From hydrogen to the heavy elements

From the elements to dust

From dust to the volatile material

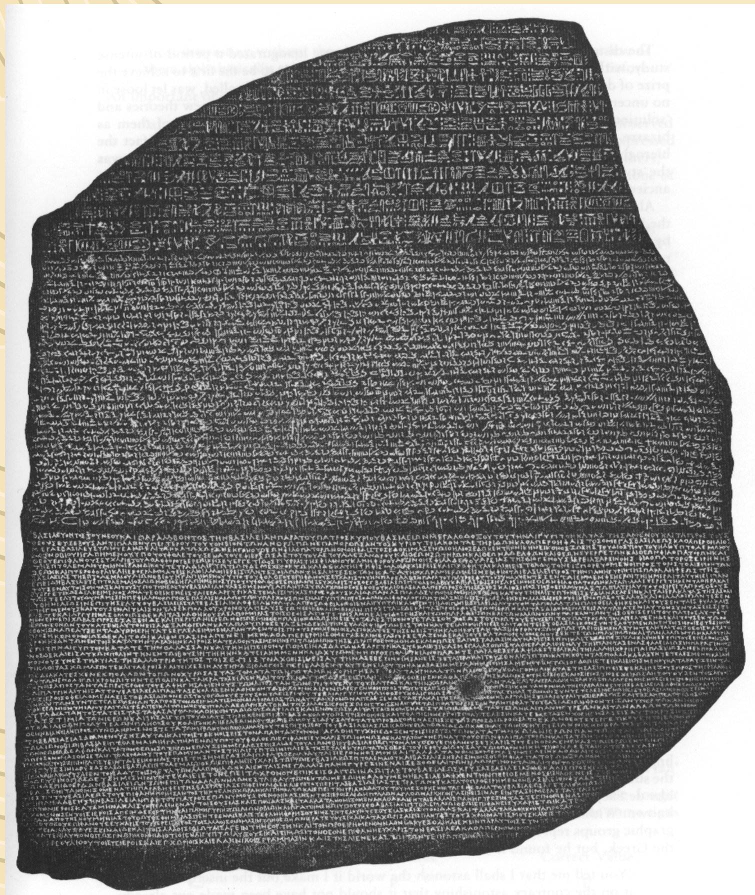
From the solar nebula to the present solar system





ROSETTA: The Comet Mission

The Rosetta Stone Was The Key To Decipher The Hieroglyphs



Rosetta can be the key to our understanding of the origin and evolution of the Planetary System

Target:

Comet 67P/Churyumov- Gerasimenko

Launch: 2 March 2004, 7:17 UTC

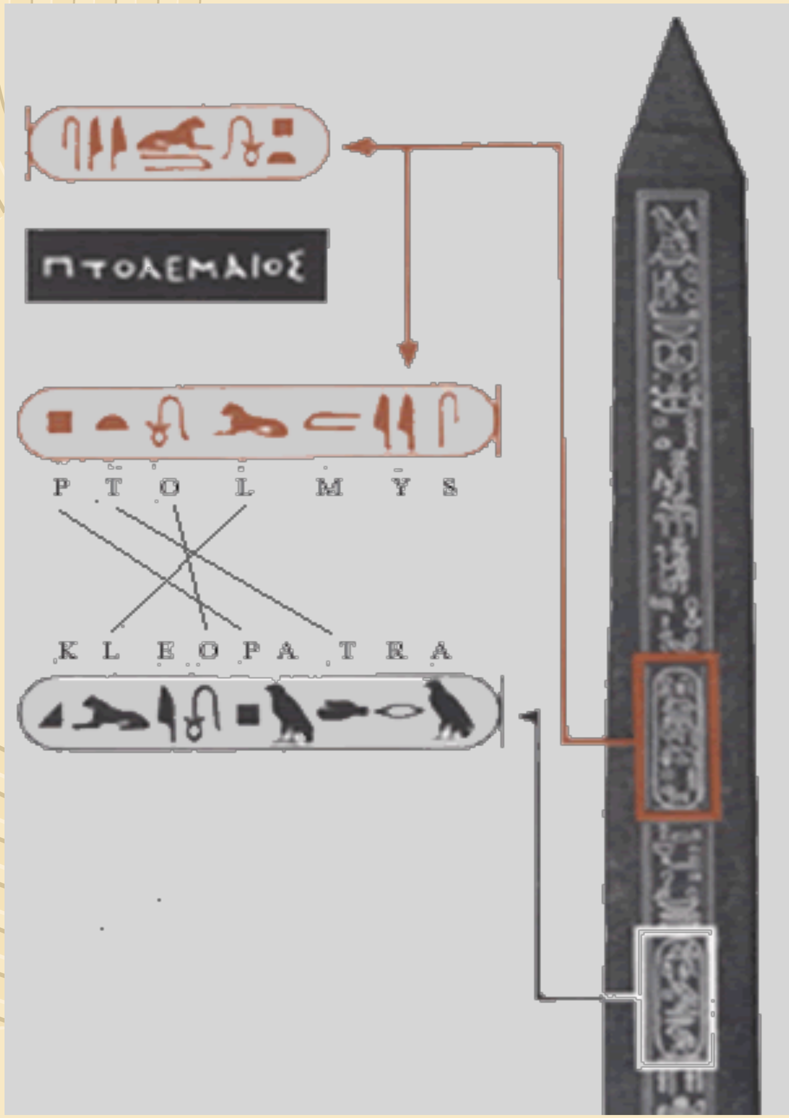
Onboard is a small station to be deployed onto the comet

A New Name For The Lander: PHILAE

The Rosetta Stone was not the only clue used in deciphering the hieroglyphs

Royal cartouches of Cleopatra and Ptolemy on the Philae obelisk allowed identification of phonetic writing

The PHILAE lander will contribute to Rosetta's task to unravel the origin of our solar system



The Rosetta Mission

Scientific Objectives:

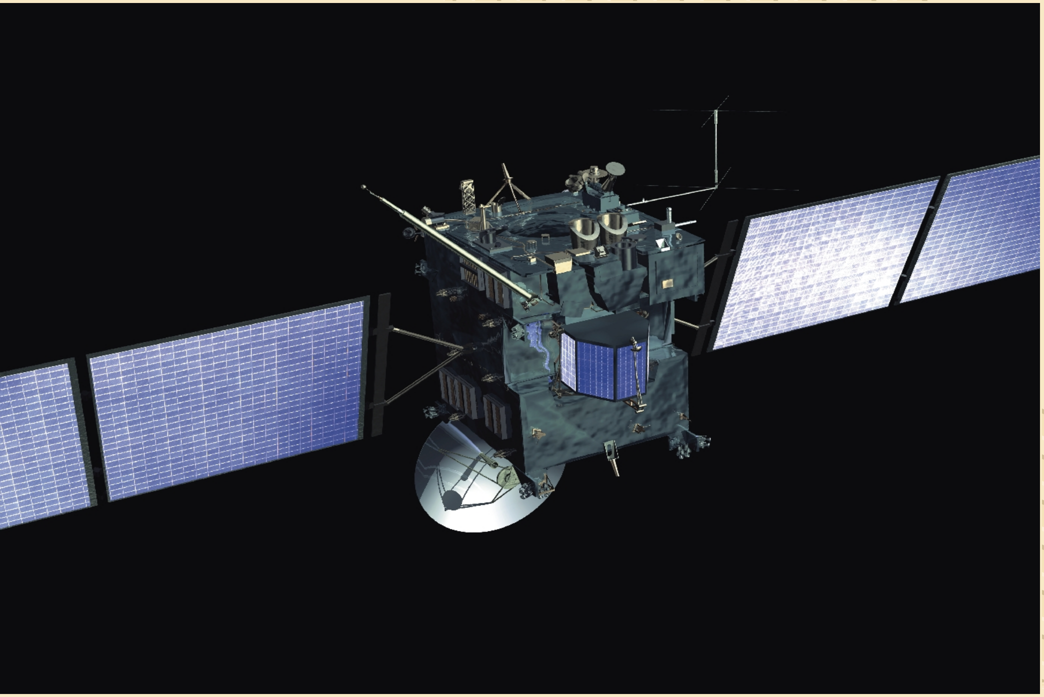
Study

The origin of comets

Relationship between comets and interstellar material

The origin of our Solar System

The Origin of Life



Orbiter Payload:

Imaging and Spectrometry (UV-Submm)

Dust and Gas Massspectrometers (Isotopic ratios) Dust Environment

Plasma

Interaction with the Solar Wind

Lander

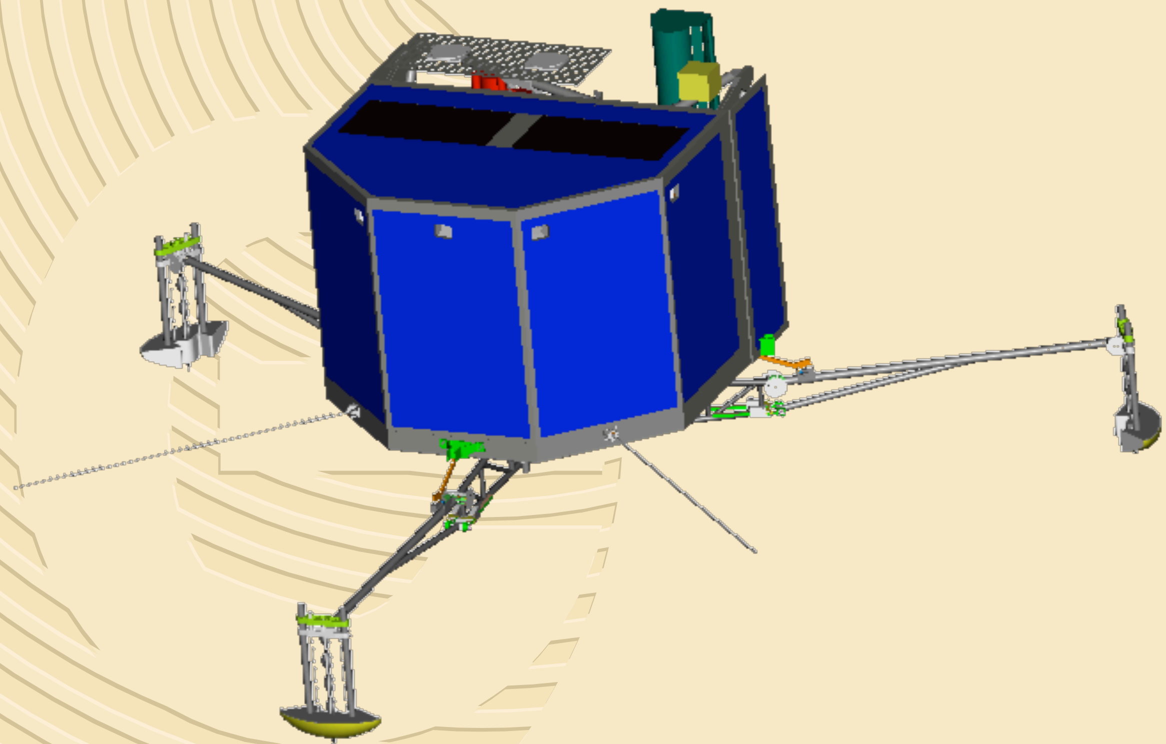
Lander: Design Characteristics

Landing gear

- damping
- rotation and variation of height
- anchoring

Energy and thermal

- solar cells
- primary and secondary batteries
- no radioactive sources



Lander: Design Characteristics

Landing gear

- damping
- rotation and variation of height
- anchoring

Energy and thermal

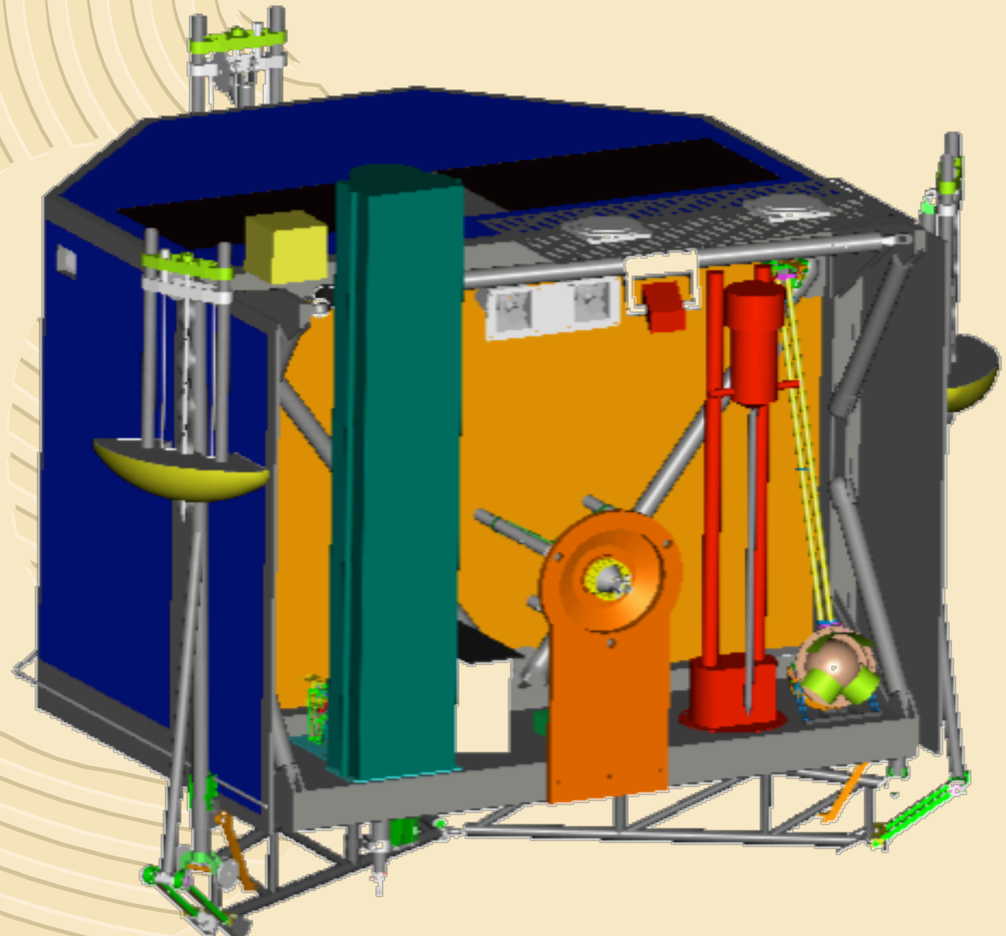
- solar cells
- primary and secondary batteries
- no radioactive sources

Accommodation

- some instruments on “balcony”
- other science in “warm” compartment

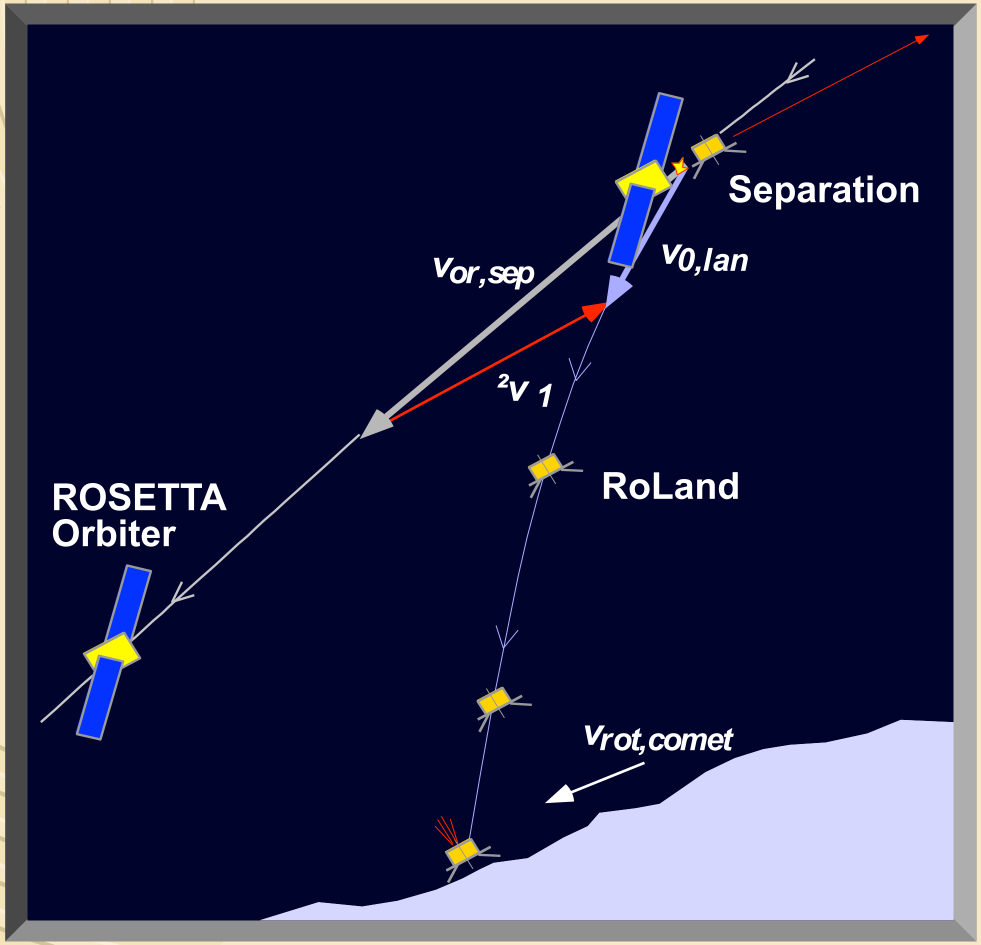
Data

- common processors
- transmission 16 kb/s via Orbiter



How to land on a comet

Principle: eject Lander from Orbiter opposite to orbital velocity



- align orbiter attitude
- eject with suitable velocity
- descent by gravity, accelerated
- position stabilized by gyro
- soft landing
- hold down and anchor

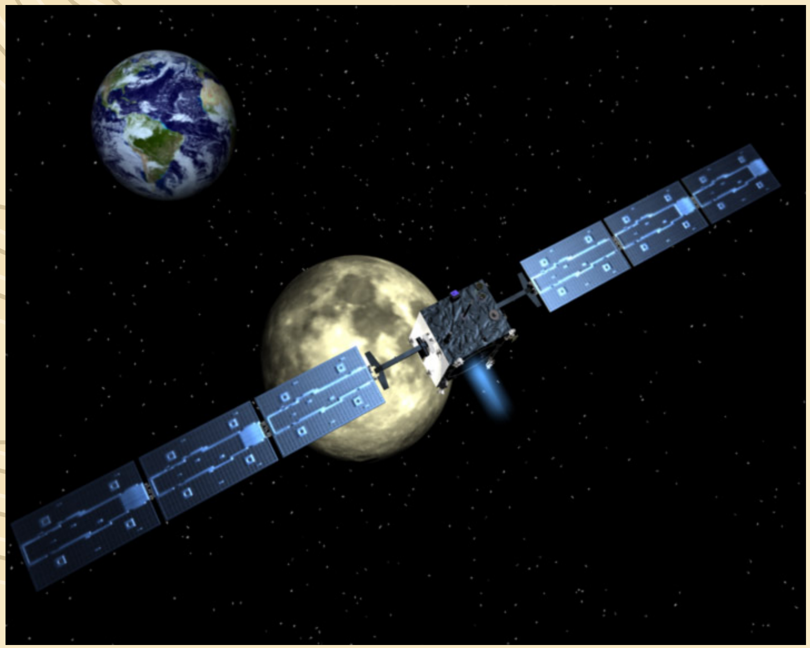
the problem is not a soft landing, but remaining on the surface!

Escape velocity < 1m/s

SMART-1 Mission

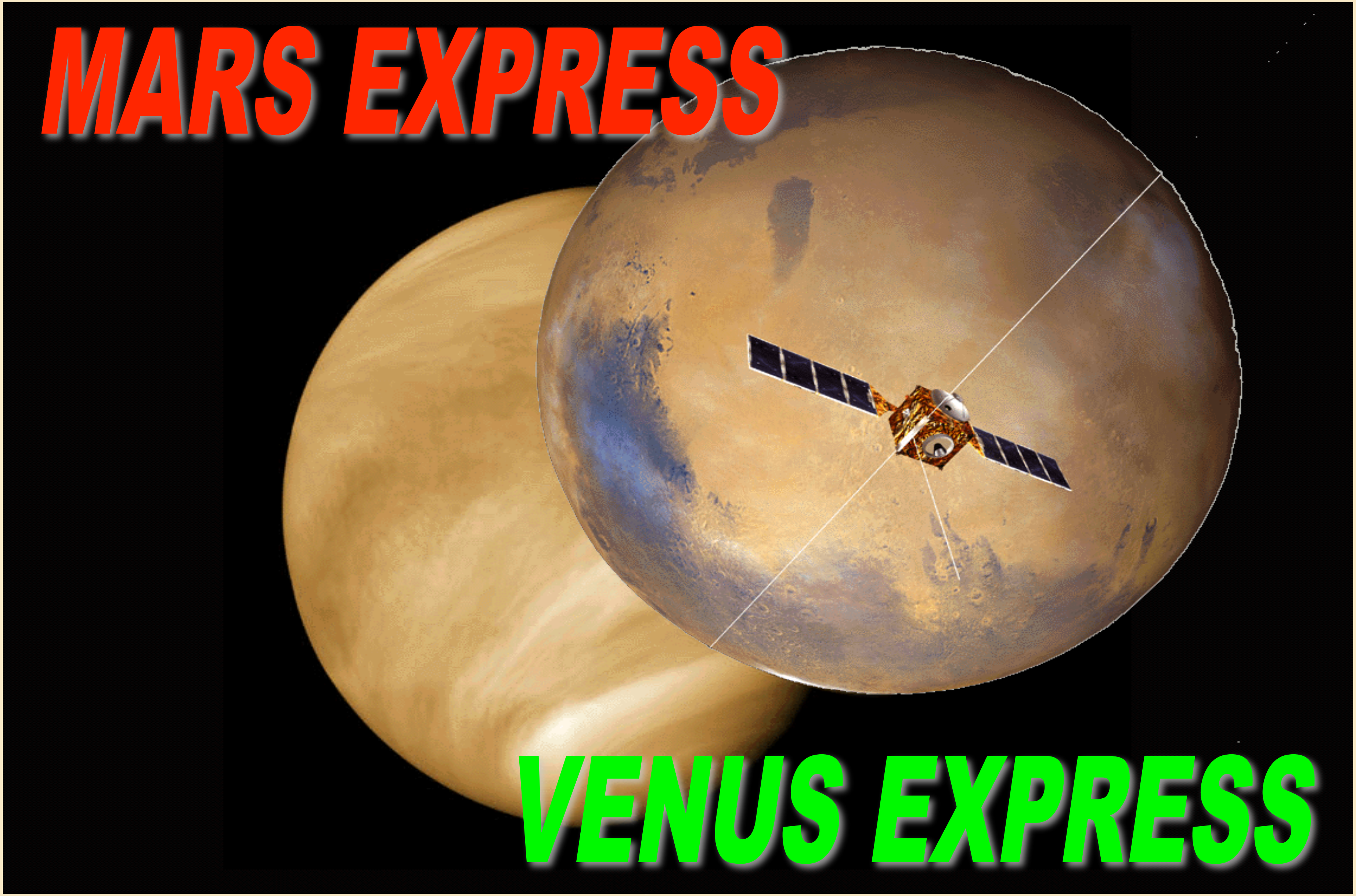
ESA SMART Programme

- Small Missions for Advanced Research in Technology
- Spacecraft and payload technology demonstration for future cornerstone missions
- early opportunity for science
- Management: faster, cheaper, smarter (& harder)



SMART-1

- test Solar Electric Propulsion to the Moon for Bepi Colombo/Solar Orbiter
- SMART-1 approved sept. 99, 84 MEuro
- 15 kg payload)
- 350 kg spacecraft
- Lunar Orbit Capture mid-November 04
- Lunar Science Mission to start Dec04/Jan05


MARS EXPRESS
VENUS EXPRESS

Mars Express Scientific Objectives

Global 3-D colour high-resolution photogeology

Super-resolution imaging of selected areas

Global mineralogical mapping

Global atmospheric circulation and composition

Water, ozone and dust cycles

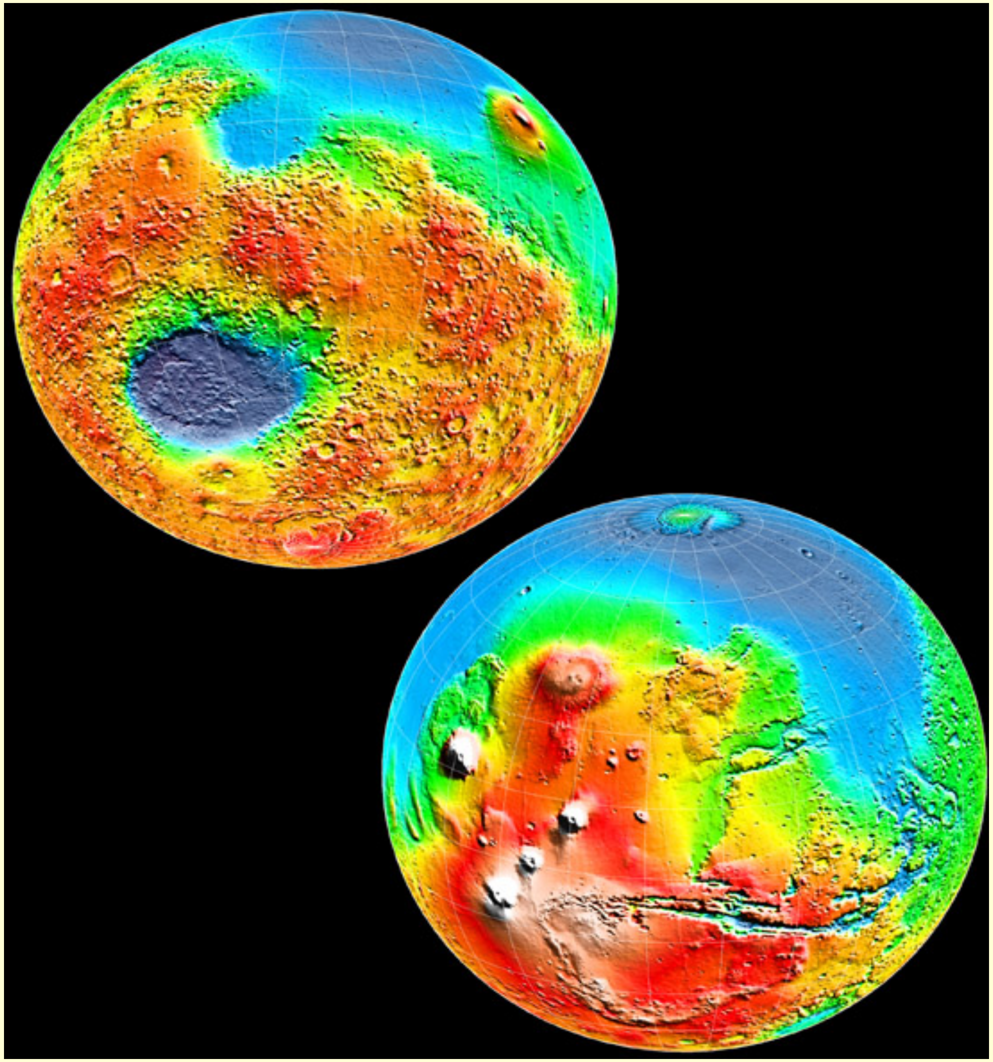
Subsurface structure a few km down to permafrost

Surface-atmosphere interactions

Interaction of upper atmosphere with solar wind and atmospheric escape

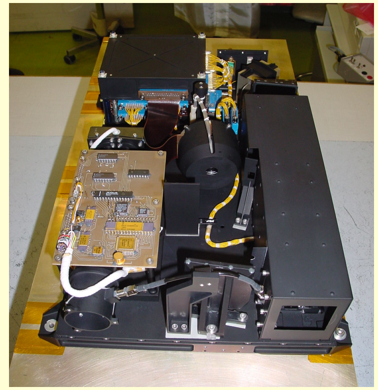
Gravity anomalies, surface roughness with

Radio science

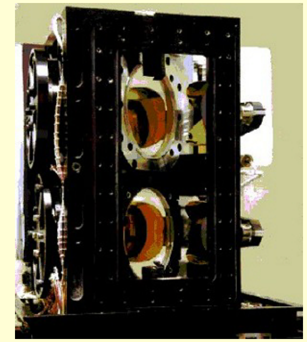


Mars Express Instruments

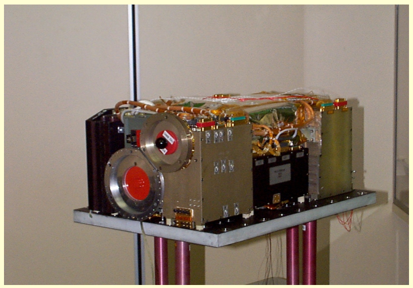
HRSC: High Resolution Stereo Camera



SPICAM: Ultraviolet and Infrared Atmospheric Spectrometer

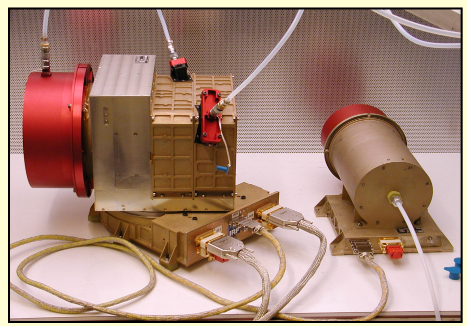


PFS: Planetary Fourier Spectrometer

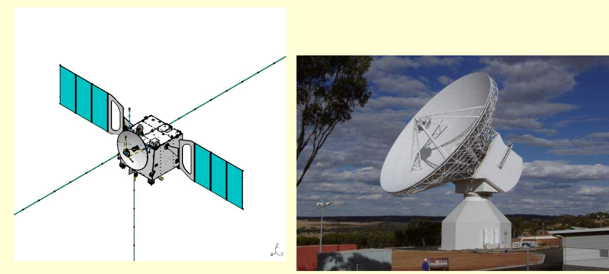


OMEGA: Visible and Infrared Mineralogical Mapping Spectrometer

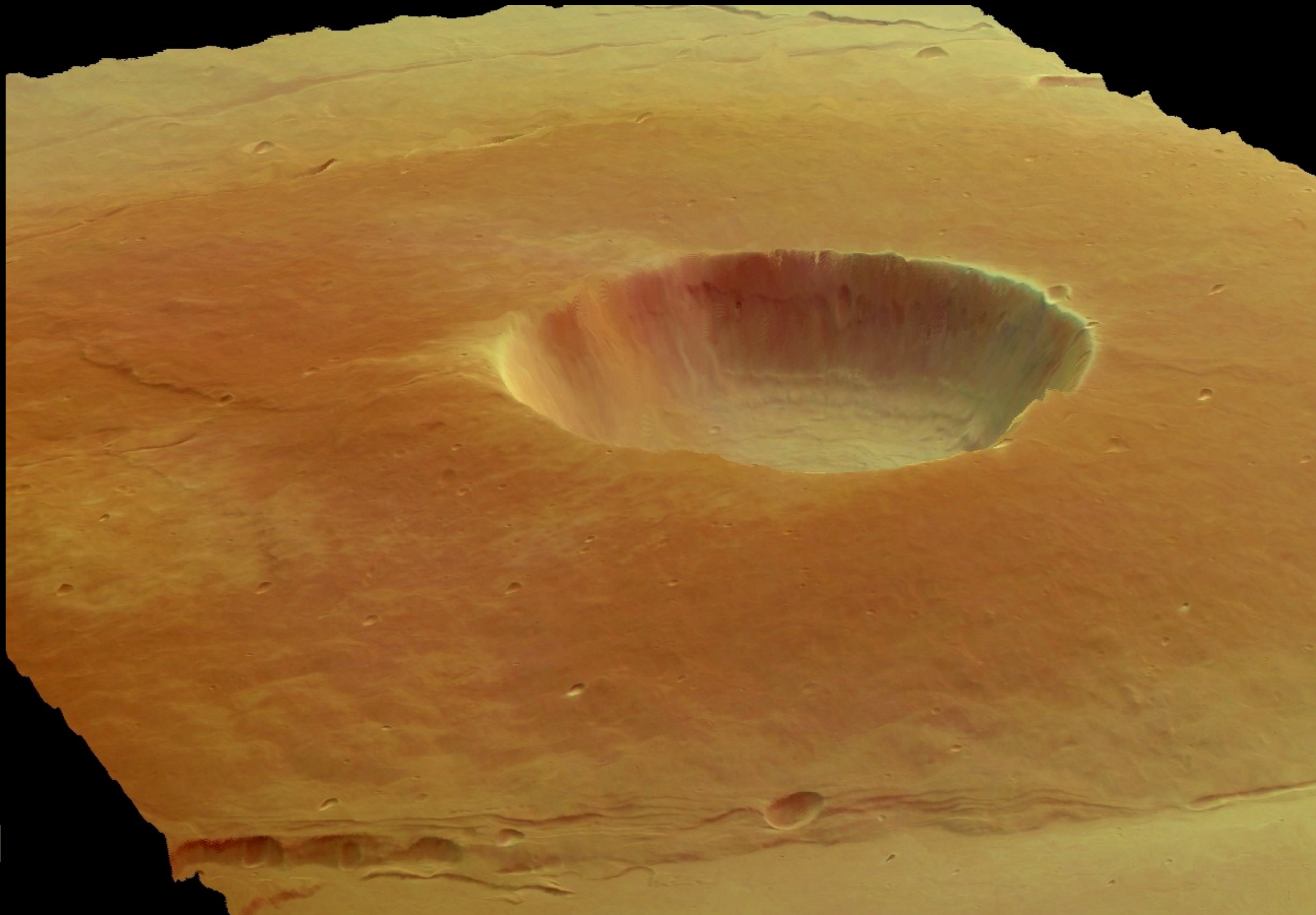
MARSIS : Sub-surface Sounding Radar Altimeter



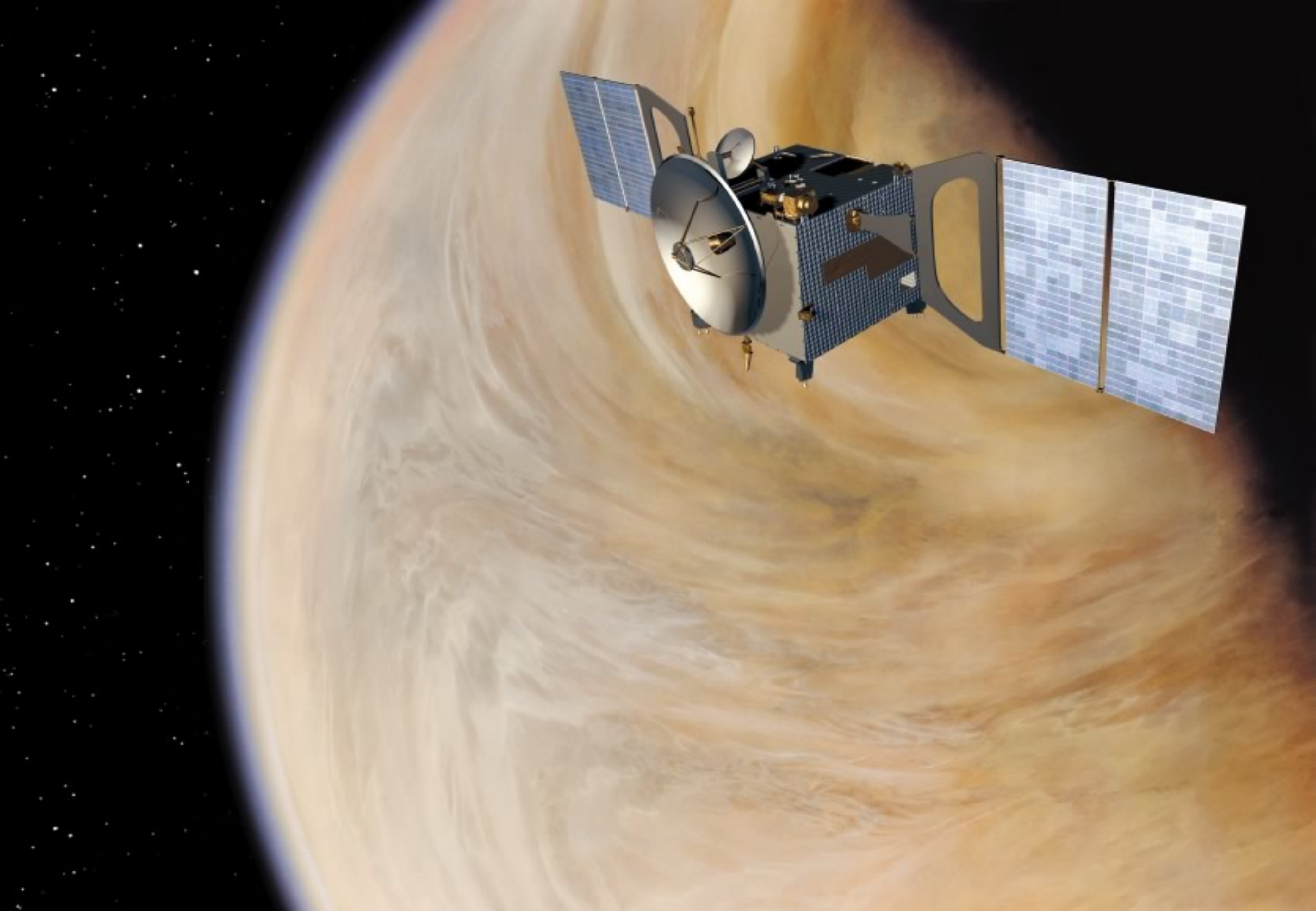
ASPERA: Energetic Neutral Atoms Analyser



MaRS: Mars Radio Science Experiment



Albor Thol



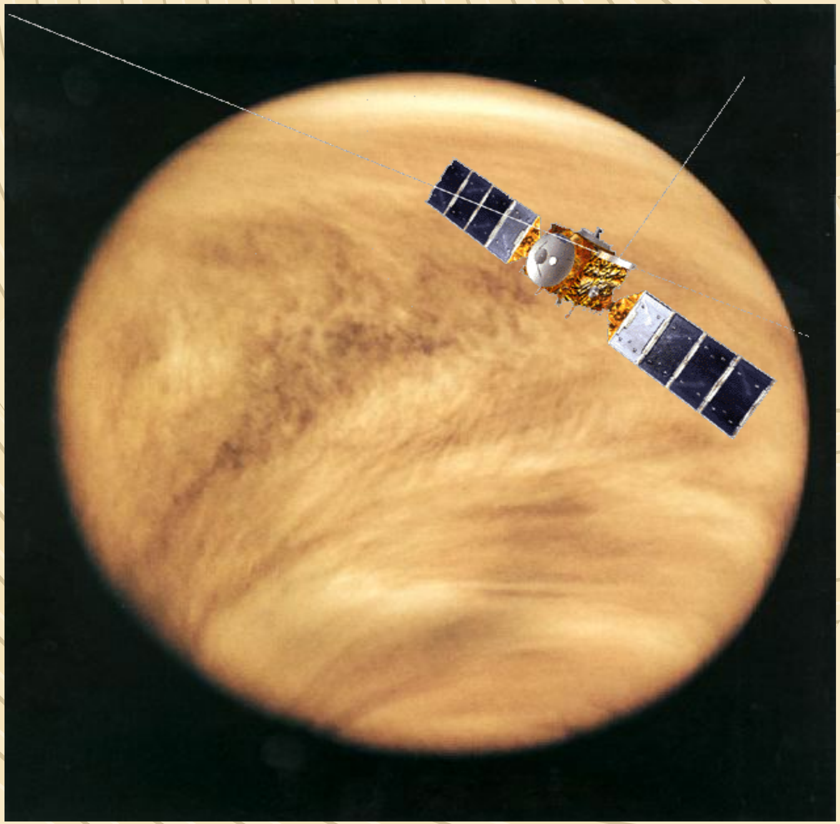
Mission Scenario

➡THE VENUS EXPRESS MISSION

11/05

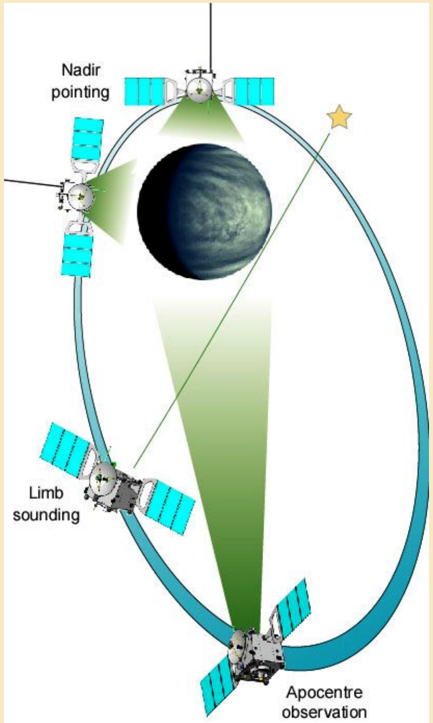
5 month cruise

04/06



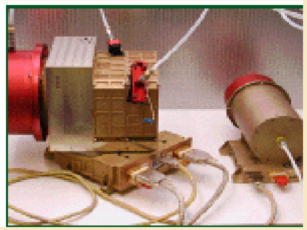
1 venusian year = 224 days

2 Venusian Years

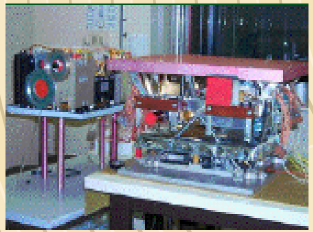


Science Payload

➡ VENUS EXPRESS INSTRUMENTS

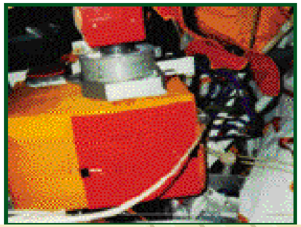


ASPERA
S. Barabash, IRF Kiruna (SE)

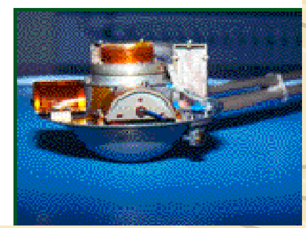


VIRTIS
P. Drossart, Obs. Meudon (FR)

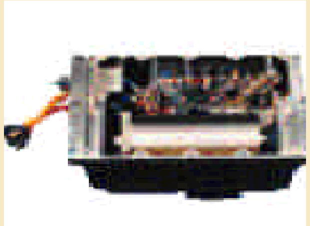
VENSIS
G. Picardi, Univ. Rome (IT)



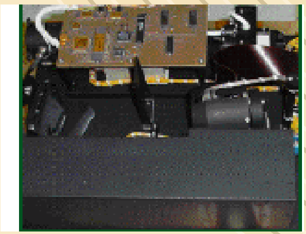
PFS
V. Formisano, CNR Rome (IT)



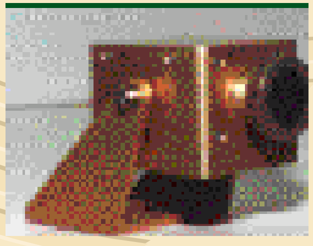
MAG
T. Zhang, OAW Graz (AT)



VeRA
B. Häusler, Univ.BW München (DE)



SPICAV
J-L.Bertaux, CNRS Verrières (FR)



VMC
W. Markiewicz, MPAe Lindau (DE)

Venus Express

Introduction

- ☞ Mission proposed as a re-use of the Mars Express Spacecraft
- ☞ Launcher, Ground system and operations facilities will be re-used as for Mars Express whenever possible
- ☞ Scientific Instruments from Mars Express (3), Rosetta (2) and two new built ones
- ☞ With only tree years from approval to launch Venus Express is the fastest developed ESA science mission

Science Objectives

Themes

- Atmospheric Dynamics
- Atmospheric Structure
- Atmospheric Composition and Chemistry
- Cloud Layer and Hazes
- Radiative Balance
- Surface Properties and Geology
- Plasma Environment and Escape processes

Mission Timeline

Launch 26 October 2005 (window extends to 25 Nov)

Arrival at Venus April 2006

Start of nominal operation June 2006

End of nominal operation/start of extended operation September 2007

End of extended operation January 2009

Orbit Characteristics

24 hours period

250-400 km pericentre altitude

66000 km apocentre altitude

90 deg inclination

Pericentre latitude ~80 deg N

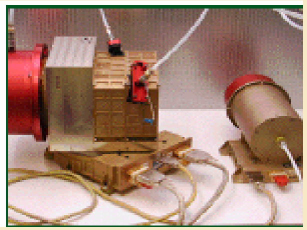
Max 8 hours communication link per orbit

Major differences VEX vs MEX

- Partly new payload
- New thermal design
- New solar panels (GaAs)
- New second (small) HGA for communication near earth
- More delta-V required, more fuel needed

Science Payload

➡ VENUS EXPRESS INSTRUMENTS



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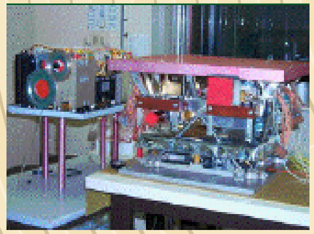

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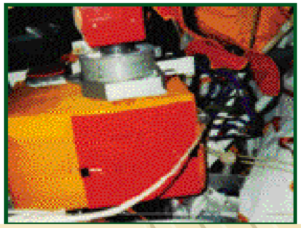

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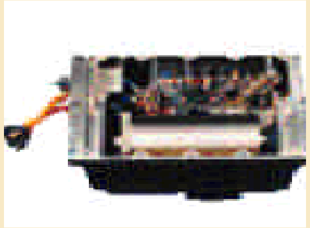

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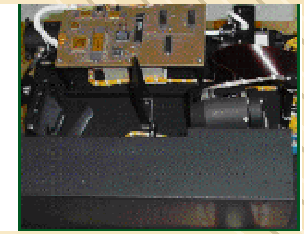

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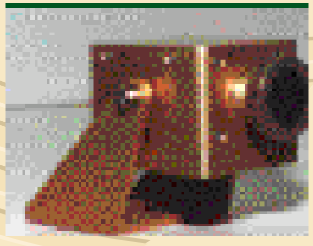


VMC
W. Markiewicz, MPAe Lindau (DE)

BepiColombo : Mission to Mercury


SOYUZ-MCCS1

Mission Profile

- Mercury Magnetospheric Orbiter (MMO)
- Mercury Planetary Orbiter (MPO)
- Chemical Propulsion Module (CPM)
- Solar Electric Propulsion Module (SEPM)

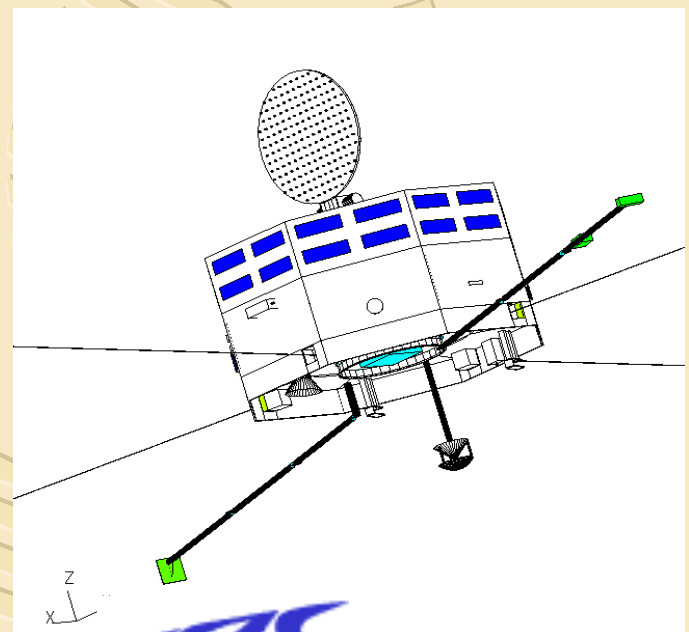
- **Combined launch on Soyuz-Fregat**
- **Solar Electric Propulsion**
- **Lunar fly-by**
- **Travel time 4.2 years**

BepiColombo Elements

Two Scientific Elements

Mercury Planetary Orbiter (MPO) = ESA

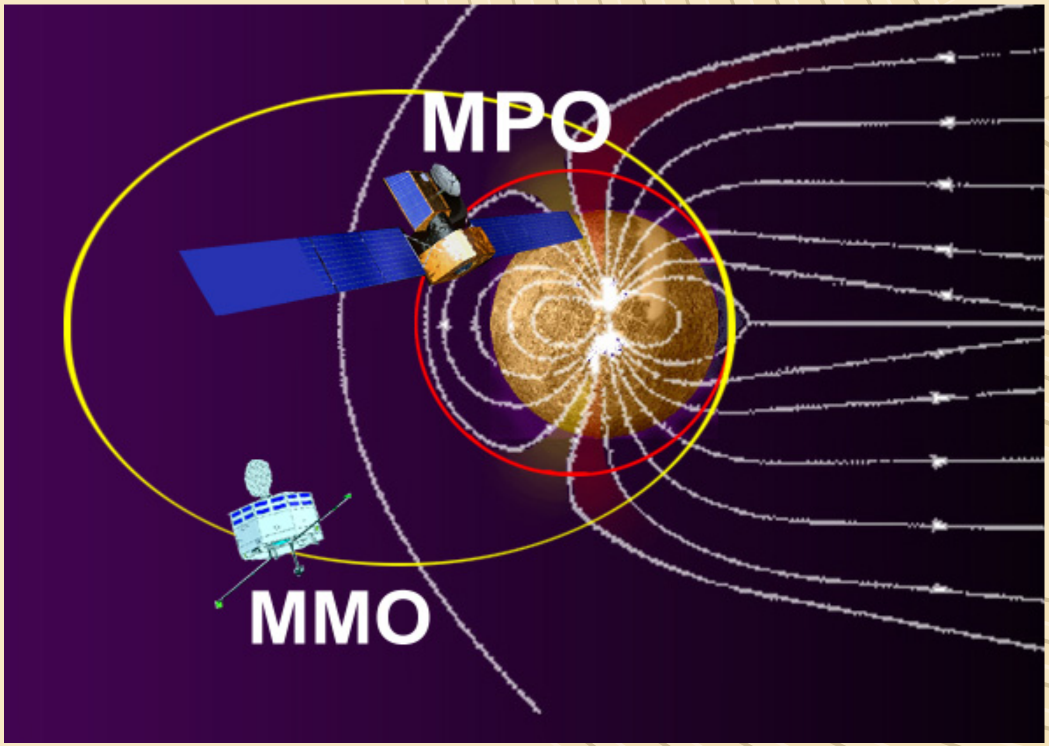
Mercury Magnetospheric Orbiter (MMO) = ISAS



BepiColombo Spacecraft operating in pairs

- **Maximises and optimises the science return**
- **Provides some degree of redundancy and risk mitigation**

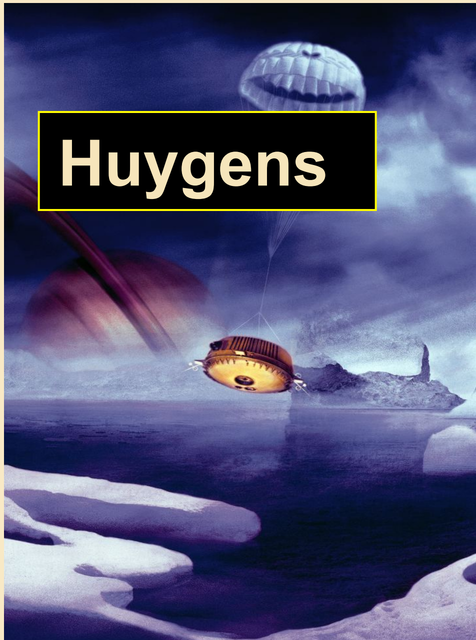
MMO & MPO on dedicated orbits



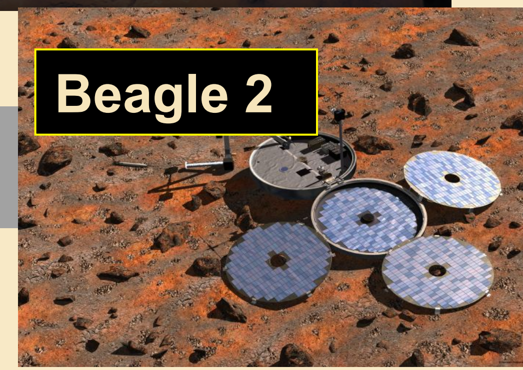
✓ MMO orbit optimized for study of magnetosphere

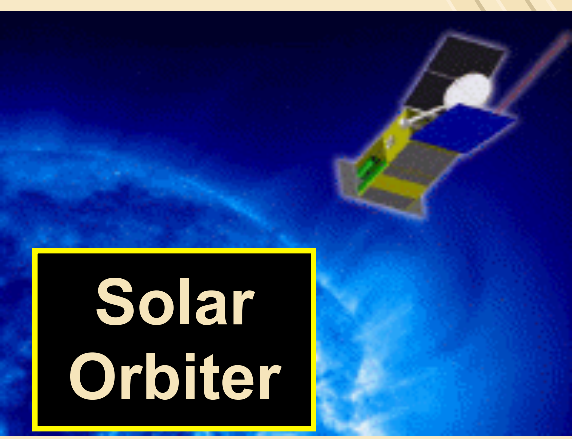
✓ MPO orbit optimized for study of planet itself

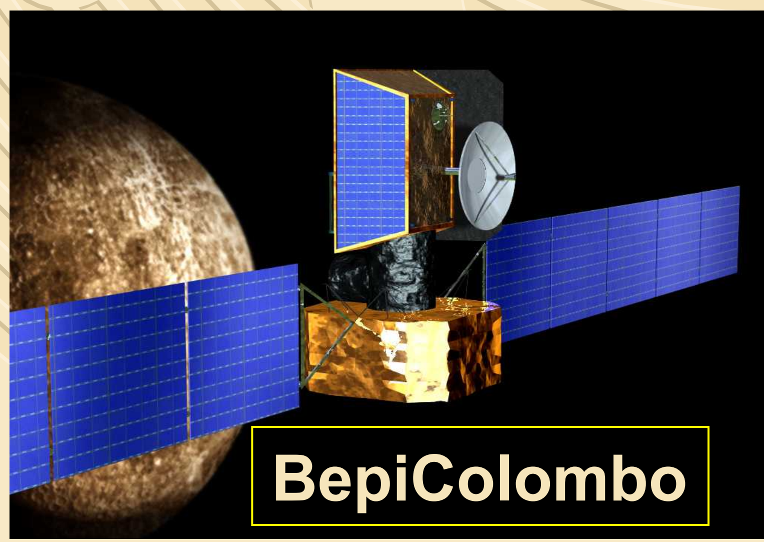
- High-accuracy measurements of interior structure
- Full coverage of planet surface at high resolution
- Optimal coverage of polar area
- Resolve ambiguities
  - exosphere
  - magnetosphere
  - magnetic field



Solar System Missions







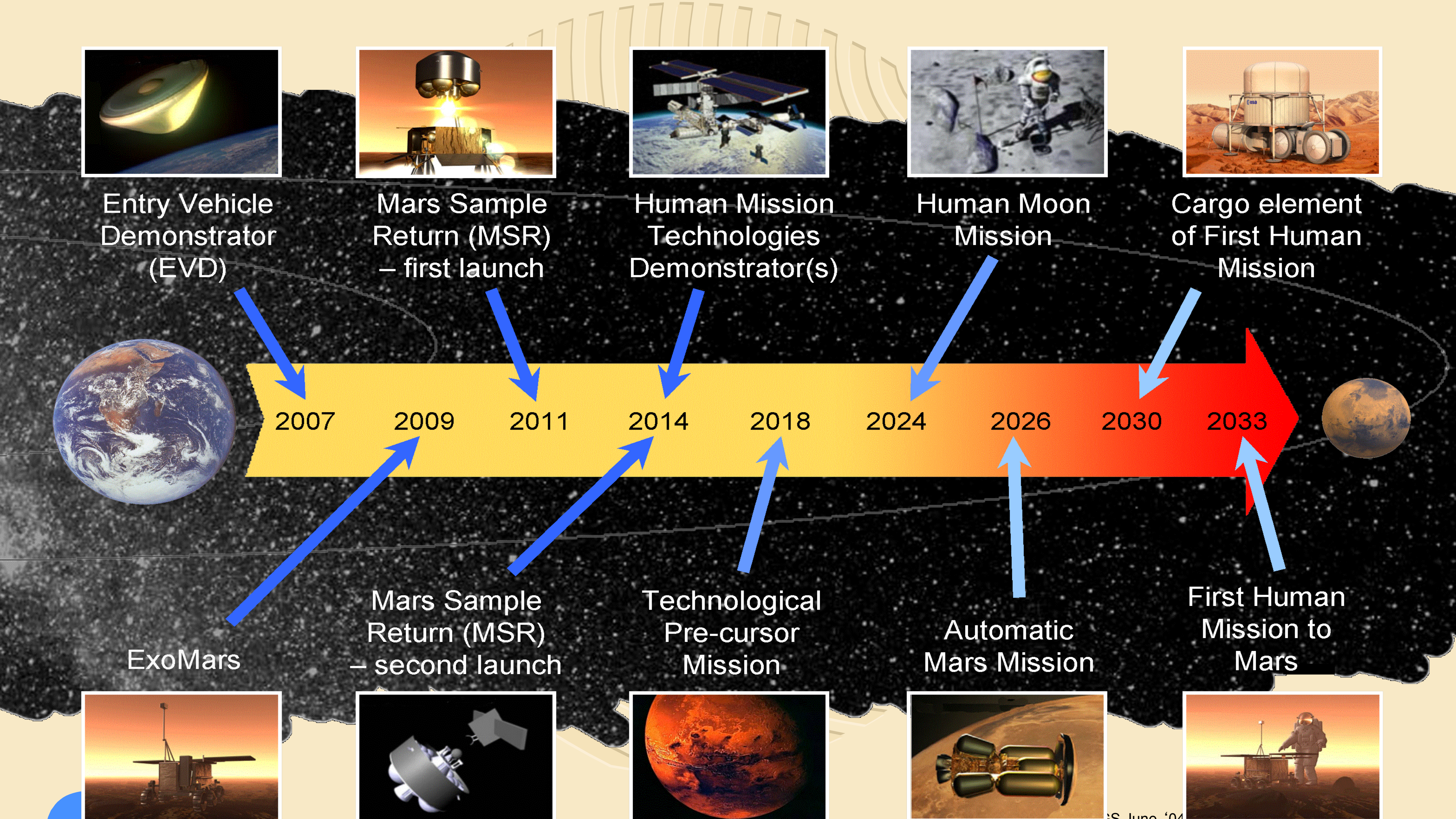
Planetary Exploration in ESA

THE FUTURE:

ESA's new Exploration Programme – Preparation of e Human Exploration of Mars

Cosmic Vision 2020 – the new long-term Science Programme

Aurora Mission Roadmap



Planetary Exploration in ESA

The Future

Call to wide scientific community to define science themes for future science programme

More than 150 proposals received

Initial assessment by Solar System Working

Workshop scheduled for 15/16 September in Paris

Themes for Solar System Exploration

- Tracing the origin of the Solar System

  Formation and dynamics of giant planets

  Structure and evolution of icy satellites

  Composition and structure of minor bodies

  - Beyond Saturn

- Life and habitability in the SS and beyond

  Evolution of solar system environments

  Traces of life in the solar system

  Comparison with extra-solar habitable worlds

  - Look deep below surfaces (Mars, Europa)